ETD 46 (25620) WC
June 2024

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Draft *Indian Standard*

Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

Grid Integration of Renewables Sectional Committee, ETD 46

Last Date of Comments: 10 July 2024

NATIONAL FOREWORD

This draft Indian Standard which is identical with International Publication IEEE Std 1547-2018 'IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces' issued by The Institute of Electrical and Electronics Engineers would be adopted by the Bureau of Indian Standards on the recommendation of the Grid Integration of Renewables Sectional Committee and approval of the Electrotechnical Division Council.

This Indian National Standard is made available under license from IEEE and is an adoption of IEEE Std 1547-2018 'IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces', 445 Hoes Lane Piscataway, NJ, 08854, USA with India specific changes.

This Indian National Standard is only valid in India as an Indian National Standard. India specific changes have been made to the adopted IEEE standard as outlined in National Annexure A.

The text of IEEE Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminology and conventions are however not identical to those used in Indian Standards. Attention is particularly drawn to the following:

Wherever the words 'IEEE Standard' appear referring to this standard, they should be read as 'Indian Standard'.

In this adopted standard, references appear to the following International Standards for which Indian Standards also exist. The corresponding Indian Standard which is to be substituted in place,is listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 61000-4-3, Electromagnetic compatibility (EMC)—Part 4-3: Testing and	IS 14700 (Part 4/Sec 3) : 2018 Electromagnetic Compatibility (EMC) Part 4 Testing and Measurement	Identical with IEC 61000-4-3
measurement techniques—Radiated, radio-frequency, electromagnetic field immunity test.	Techniques Section 24 Test methods for protective devices for HEMP conducted disturbance (First Revision)	
IEC 61000-4-5, Electromagnetic compatibility (EMC)—Part 4-5: Testing and measurement techniques—Surge immunity test.	IS 14700 (Part 4/Sec 5) : 2019 Electromagnetic compatibility (EMC): Part 4 testing and measurement techniques: Sec 5 surge immunity test (First Revision)	Identical with IEC 61000-4-5: 2017

The technical committee has reviewed the provisions of the following International Standards/Other Publications referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
ANSI C84.1	Electric Power Systems and Equipment—Voltage Ratings (60 Hz).17
IEC/TR 61000-3-7	Electromagnetic compatibility (EMC)—Part 3-7: Limits—Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems.18
IEEE Std 519™	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.[19, 20]
IEEE Std 1453™	IEEE Recommended Practice for the Analysis of Fluctuating Installations on Power Systems.
IEEE Std 1815™	IEEE Standard for Electric Power Systems Communications-Distributed Network Protocol (DNP3).

NATIONAL ANNEXURE A

(*National Foreword*)

(Normative)

A-1 This IEEE standard specifies the frequency as 60Hz for standard testing condition. However, as per Indian conditions, the frequency shall be considered as 50Hz.

A-2 Table 2 — Substitute the following for the existing:

Table 2 Applicable Voltages when PCC is Located at Low Voltage

Low-voltage winding configuration of Area EPS transformer (s)[a]	**Applicable voltages**
Grounded Wye,	Phase-to-phase and phase-to-neutral, or Phase-to-phase and phase-to-ground
Ungrounded Wye,	Phase-to-phase or phase-to-neutral
Delta[b]	Phase-to-phase
Single-Phase	Line to neutral – for 230 V DER units
Three-Phase	Line to line – for 400 V DER units

[a] A three-phase transformer or a bank of single-phase transformers may be used for three-phase systems.

[b] Including delta with mid tap connection (grounded or ungrounded).

A-3 Table 3 — Substitute the following for the existing:

TABLE 3 Minimum Measurement and Calculation Accuracy Requirements for Manufacturers[a]

Time frame	**Steady-state measurements**			**Transient measurements**		
Parameter	**Minimum measurement accuracy**	**Measurement window**	**Range**	**Minimum measurement accuracy**	**Measurement window**	**Range**
Voltage, RMS	(± 1% V_{nom})	10 cycles	0.5 p.u. to 1.2 p.u.	(± 2% V_{nom})	5 cycles	0.5 p.u. to 1.2 p.u.
Frequency [b]	10 mHz	50 cycles	40 Hz to 55 Hz	100 mHz	5 cycles	40 Hz to 55 Hz
Active Power	(± 5% S_{rated})	10 cycles	0.2 p.u. $<P<$1.0 p.u.	Not required	N/A	N/A

Reactive Power	(± 5% S_{rated})	10 cycles	0.2 p.u. <P <1.0 p.u.	Not required	N/A	N/A
Time	1% of measured duration	N/A	5 s to 600 s	2 cycles	N/A	100 ms < 5 s

[a] Measurement accuracy requirements specified in this table are applicable for voltage THD <2.5% and individual voltage harmonics <1.5%.

[b] Accuracy requirements for frequency are applicable only when the fundamental voltage is greater than 30% of the nominal voltage.

A-4 Table 4 — Substitute the following for the existing:

TABLE 4 ENTER SERVICE CRITERIA FOR DER OF CATEGORY I, CATEGORY II, AND CATEGORY III

Enter service criteria		**Default settings**	**Ranges of allowable settings**
Permit service		Enabled	Enabled/Disabled
Applicable voltage within range	Minimum value	≥ 0.9 p.u.	0.8 p.u. to 0.9 p.u.
	Maximum value	≤ 1.1 p.u.	1.1 p.u. to 1.2 p.u.
Frequency within Range	Minimum value	≥ 49.5 Hz	49.0 Hz to 49.9 Hz
	Maximum value	≤ 50.1 Hz	50.1 Hz to 51.0 Hz

A-5 Substitute the following for the existing Cl. 4.10.3 (b):

DER shall be capable of delaying enter service by an intentional adjustable minimum delay when the Area EPS steady-state voltage and frequency are within the ranges specified in Table 4. The adjustable range of the minimum intentional delay shall be 0 s to 600 s with a default minimum delay of 60 s.

A-6 Substitute the following for the existing 1st para of Cl. 4.10.4:

The DER shall operate in parallel with the Area EPS without causing step changes in the RMS voltage at the PCC exceeding 5% of nominal when the PCC is at medium voltage, or exceeding 5% of nominal when the PCC is at low voltage.

A-7 Table 7 — Substitute the following for the existing:

Table 7: Minimum reactive power injection and absorption capability

Injection capability as % of nameplate apparent power (kVA) rating	**Absorption capability as % of nameplate apparent power (kVa) rating**
60	60

A-8 Table 8 — Substitute the following for the existing:

Table 8: Voltage-reactive power settings for normal operating performance Category A and Category B DER

Voltage-reactive Power parameters	**Default settings**		**Ranges of allowable settings**	
	Category A	**Category B**	**Minimum**	**Maximum**
V_{Ref}	V_N	V_N	0.9 V_N	1.1 V_N
V_2	V_N	V_{Ref} – 0.02 V_N	Category A: V_{Ref} Category B: V_{Ref} – 0.03 V_N	V_{Ref} [c]
***Q*2**	0	0	100% of nameplate reactive power capability, absorption	100% of nameplate reactive power capability, injection
***V*3**	*V*N	V_{Ref} + 0.02 V_N	V_{Ref} [c]	Category A: V_{Ref} Category B: V_{Ref} + 0.03 V_N
***Q*3**	*0*	*0*	100% of nameplate reactive power capability, absorption	100% of nameplate reactive power capability, injection
***V*1**	0.9 *V*N	V_{Ref} – 0.08 V_N	V_{Ref} – 0.18 V_N	V_2 – 0.02 V_N [c]
***Q*1** [a]	25% of nameplate apparent power rating, injection	60% of nameplate apparent power rating, injection	*0*	100% of nameplate reactive power capability, injection[b]
***V*4**	1.1 *V*N	V_{Ref} + 0.08 *V*N	*V*3+0.02 *V*N [c]	*V*Ref + 0.18 *V*N
***Q*4**	25% of nameplate apparent	60% of nameplate apparent	100% of nameplate reactive power capability, absorption	*0*

	power rating, absorption	power rating, absorption		
Open loop response time	10 s	5 s	1 s	90 s

[a]The DER reactive power capability may be reduced at lower voltage.

[b]If needed DER may reduce active power output to meet this requirement.

[c]Improper selection of these values may cause system instability.

A-9 Table 9 — Substitute the following for the existing:

Table 9 —Active power-reactive power settings for normal operating performance: Category A and Category B DER

Active power-reactive power parameters	**Default settings**		**Ranges of allowable settings**	
	Category A	**Category B**	**Minimum**	**Maximum**
P_3	P_{rated}		$P_2 + 0.1P_{rated}$	P_{rated}
P_2	0.5 P_{rated}		0.4 P_{rated}	0.8 P_{rated}
P_1	The greater of 0.2 P_{rated} and P_{min}		P_{min}	$P_2 – 0.1$ P_{rated}
P'_1	The lesser of 0.2 P'_{rated} and P'_{min}		$P'_2 – 0.1$ P'_{rated}	P'_{min}
P'_2	0.5 P'_{rated}		0.8 P'rated	0.4 P'rated
P'_3	P'_{rated}		P'_{rated}	$P'_2 + 0.1$ P'_{rated}
Q_3	25% of nameplate apparent power rating, absorption	60% of nameplate apparent power rating, absorption	100% of nameplate reactive power absorption capability	100% of nameplate reactive power injection capability
Q_2	0			
Q_1	0			
Q'_1	0			
Q'_2	0			
Q'_3	60% of nameplate apparent power rating, injection			
Note – P_{rated} is the nameplate active power rating of the DER				

P'_{rated} is the maximum active power that the DER can absorb
P_{min} is the minimum active power output of the DER
P'_{min} is the minimum, in amplitude, active power that the DER can absorb
P' parameters are negative in value

A-10 Table 11, Table 12, Table 13: Substitute the following for the existing:

Table 11, Table 12 and Table 13: DER response (shall trip) to abnormal voltages for DER of abnormal operating performance

Shall trip function	**Ranges of allowable settings**	
	Voltage (p.u. of nominal voltage)	**Clearing time (s)**
Overvoltage	V > 1.1	2 s
Undervoltage	V < 0.8	2 s

A-11 Table 18- Substitute the following for the existing:

Table 18 – DER response (shall trip) to abnormal frequencies for DER of abnormal operating performance Category I, Category II, and Category III (see Figure H.10)

Shall function	**Default settings**		**Ranges of allowable settings**	
	Frequency (Hz)	**Clearing time (s)**	**Frequency (Hz)**	**Clearing time (s)**
OF	52.0	0.2	50.05 - 52.0	0.16-1000
UF	47.5	0.2	47.5 - 48.8	0.16-1000

A-12 Substitute the following for the existing Cl. 6.5.2:

The DER shall continue normal operation within the frequency range of 47.5 Hz to 52 Hz. For Over Frequency (OF) events in the 50.05 Hz to 52.0 Hz, the DER shall continue operating and shall adjust the generated power to additional requirements of the Central Electricity Authority (CEA). In the absence of Central Electricity Authority requirements, the DER operator shall operate according to the requirements of the connected Area EPS, distribution license.